Social Evolution Through Massively Decentralised Distributed Resilient Networks

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Abstract

The article discusses the present state of human life on the planet, and how it is likely to change in the near and long term future. Analysis of vast amounts of data suggests that humans are on an unsustainable trajectory, both environmentally and socially. A strategy for steering humanity's future is presented, focusing on five main pillars, which have in common the destabilisation of established powers through massively decentralised distributed resilient networks, and the abandonment of the indefinite consumption growth economic model. Particular emphasis is given to overall causes of the problems, rather than specific symptoms. The essay ends with philosophical speculations about the long term future of the human race and its space in the cosmos.

I. Introduction

Human Life on Earth, one of the many (unintended) consequences of cosmic evolution, is facing its greatest threats – life-supporting systems in a state of decline, reduced biocapacity of the planet, global increase in inequality, and possible risks of extinction. In this essay we will discuss the current challenges and opportunities in face of the data and evidence that we already have, as well as more speculative futures. We will keep the two discussions separate, albeit they are connected at some level, and we will refer to them as present and future scenarios. A discussion about the underlying problem, which ties in the present and the future will also be included, as well as its philosophical implications and the long term vision for humanity.

II. Present scenario

I. Historical context

Humanity has experienced an unprecedented growth in the last 200 years. According to evolutionary biologists, anatomically modern homo sapiens came into being some 200,000 years ago on Earth. This means that much of our technological and social development happened in the last 0.1% in the arrow of time of human existence. To put things into perspective, in the early 20th century the average life expectancy for a person was 31, not far from that of hunter gatherer societies during the upper Palaeolithic some 50,000 years ago; just a century later in 2010, the world average was up to 67.2. The reasons for this dramatic change are various and debated. The philosophical and social ideas that fuelled progress have been developed centuries of even millennia before, such as the philosophically-inclined Greek *poleis* 2,500 years ago and the scientific revolution started by Galileo some 500 years ago. However, it is clear that the discovery of a particular technology enabled social ideologies and scientific methodologies to flourish and conquer the planet: cheap and abundant hydrocarbon energy, in the form of coal, oil, and natural gas.

If hydrocarbon energy was the fuel to this revolution, the scientific methodology represented the set of tools that made it all possible, while the sociopolitical system of semi-inclusive, quasi-democratic institutions, globalised literacy and education can be considered the glue that kept it all together. But there was one aspect that accelerated the change, and that very thing is now undermining the survival chance of humanity: the need for indefinite, exponential growth in consumption.

II. Current challenges

Humanity is presently facing a number of diverse challenges, but they can broadly be summarised in two main categories: environmental and social.

On the environment side, the list is quite extensive. Climate change, sea level rise, ocean acidification, species extinction and loss of biodiversity, pollinator decline, coral bleaching, eutrophication, habitat destruction, overgrazing, extensive monoculture, pesticide drift, land degradation and land pollution, desertification, nuclear and radiation accidents, water crisis, ocean dumping, oil spills, marine debris and microplastics, overfishing, blast fishing, bottom trawling, deforestation, bioaccumulation, landfills, incinerators, and the Great Pacific Garbage Patch are just a few of the environmental problems we are facing daily, and for which there is no immediate and simple solution. All of them can be clustered into an overarching category: overconsumption and disregard for the effects of economic activity on the biosphere. This is often referred to as, for lack of a better term, *environmentally unsustainable*.

On the social level there are two opposite trends happening simultaneously. On one side we are experiencing, on average, the highest quality of life ever in human history, with percentages of poor, malnourished and uneducated people at an all time low (relative to the total population), as well as the highest life expectancy, lowest infant mortality and lowest rates of violence. On the other side there is an opposite trend, which has to do with an overwhelming increase in inequality. If extreme poverty has clearly declined worldwide, the world has never been more unequal than today. According to the latest report from Oxfam, the wealth of the richest 1% is now 65 times the total wealth of the bottom half of the world's people, and even more striking, the combined wealth of the world's richest 85 people is now equivalent to that owned by half of the world's population – or 3.5 billion of the poorest people. Societies are becoming richer in absolute terms, but many countries are experiencing exacerbating inequality. Extensive research shows that inequality has devastating effects on society, as almost every social indicator gets worse as countries become more unequal: murder, obesity, teenage pregnancy, depression, stress, mental health problems, alcoholism, drug abuse, physical health problems, literacy, just to name a few. Similar to the environmental side, this situation can be called *socially unsustainable*. The convergence of the two is worrisome to say the least, and the continuation of the status quo into the future is a clear recipe for disaster.

III. Addressing present environmental and social unsustainability: a strategy for resilience

Humans need, broadly speaking, two things: natural resources to adequately support life and an inclusive society that allows for basic freedoms: creative, spiritual, cultural, physical, and intellectual development. The major threats to these two conditions that prevent us from building a long-lasting stable and thriving society have common roots: the indefinite growth paradigm and the concentration of power.

Power resides in the ability to store potential energy in various forms. Examples of this include the military (violent force), state-issued currencies and fractional reserve banking (which control the flow of the economy), and large scale power plants (nuclear reactors, oil wells). Just as war is the continuation of politics by other means, politics is the continuation of economics by other means. Destabilising the balance of power at the economic level can have consequences that ripple through the entire system.

It is the position of the author that referring to a single technology or ideological position as a solution the to problems of society is wrong, because it oversimplifies complex issues that are closely interconnected. However, there is an underlying general trend that can begin the process of steering humanity's future in the right direction, and that is the **destabilisation of established powers through massively decentralised distributed resilient networks**.

Specific social conditions and technologies can enable such change to occur, in particular, in the field of energy capturing and storage, manufacturing and food production, financial and economic systems, and processes for decision making. The convergence of these cultural trends and technological tools are, in the author's opinion, the best bet that humanity has in steering the future in a positive direction.

III. Near-Future Solutions

I. Distributed Energy Capture and Storage

Oil, coal, natural gas, and nuclear provide the vast majority of energy that we consume, and they are all highly centralised. Solar, wind, and to a lesser extent hydro, geothermal, and biomass, can be localised and provide the energy requirements of the communities that seek to use them. A network of interconnected nodes through smart grids, managed by open source software and hardware, can intelligently balance the load between and among the communities, cities, countries, and states, depending on the requirements. It is of vital importance for such tools to be used and distributed under open source licenses, both in software, hardware, blueprints, data, and processes. This increases the intrinsic resilience of the network, allowing more nodes to connect, at a much lower barrier to entry than their commercial, closed, proprietary counterparts would allow. The distributed nature of the network avoids general blackouts, it is less vulnerable to natural and man-made disasters – which can be in the form of power plant malfunctioning, nuclear fallout, terrorist attacks both physical and cyber – and allows for minimum energy losses by avoiding large distances between energy production and energy usage and the real-time exchange of surplus energy in an open market. This reduces the need for energy storage, which can be complemented and addressed locally via in-house low-tech solutions, or through hydrogen storing for sensitive buildings and areas of intermittent energies. With each building, each road, each house, each vehicle becoming a small power plant, the strength of the network increases exponentially, taking power away from large corporations and distributing it across the larger population.

II. Ubiquitous Digital Manufacturing

The ability to build useful objects and tools for everyday life is essential for the development of a society. Digital Manufacturing makes it possible for small groups of people or even individuals to create at will virtually any object, starting with a digital blueprint and raw materials. Being a technology in exponential progress, it will become soon viable to create anything by building with molecular precision at a fraction of today's cost, including computer chips, cars, solar photovoltaics, batteries, and even food. Within reason, in the near future, anyone with access to a Molecular Compiler (MC) will be able to build anything. The raw materials necessary for this can come from existing landfills using Molecular Decompilers, thus solving two immense problems at once. The energy required to run MC machines can be collected through solar PV, wind and other technologies, which can be created by the MC themselves. The MC can of course be self-replicating, so if the designs are open source, one needs not to even purchase the machines, as they can be produced at will from a small initial set, growing organically as the network requires.

III. Distributed Cryptocurrencies

We know from historical evidence that simply outlining what humanity ought to be doing is not a sufficient condition for actually changing societies, behaviours, or global trends.

Organisational systems tend to branch out in (almost) every possible direction, the inefficient and/or unsustainable branches die off, leaving a few to dominate the ecosystem. They might be enabled by random genetic variations (choice of advantageous random mutations over time, natural selection), environmental and geographical factors (geography hypothesis), germs, guns and steel (Diamond), religion, philosophical inclinations and general culture (culture hypothesis), inclusive political and economic institutions (Acemoglu and Robinson), new technological discoveries (technology hypothesis), or a complex combination of all of them, the latter being the position of the author.

In order for society to change several conditions need to be satisfied, the most important being economic incentives and necessity. If something were to emerge that allowed for these basic conditions to be satisfied without the need to fight natural inertial tendencies, then we would have a good chance for change to occur.

What are the potential obstacles that would prevent such a system to emerge? As previously discussed, established powers naturally tend to preserve their position, with typical symptoms being political corruption, market manipulation, global imperialism, patent-trolling, disregard for negative externalities, military invasion and occupation. Enforced national borders and tension between nations are typically due to economic disparity, with some exceptions represented by religious fanaticism. The first problem, economic disparity, can be solved through the widespread use of collaborative open source tools, processes, and softwares, which can be utilised by small communities at low marginal cost and can scale up to the level of nation-states and supra-national entities. This takes away the conditions that allow for power to be centralised, increasing resilience, and therefore greatly reducing dependence on foreign resources and the need to control them. The second problem, religious fanaticism, is more complex and has no clear solution. A promising study using nonlinear dynamics suggests that religion may be headed towards "extinction" in at least nine countries, but no conclusions can be drawn at this point.

Distributed Cryptocurrencies (DC) represent an additional condition that can facilitate the transformation process, by providing an intrinsic incentive towards sustainability, without relying on "good will" or on the hope that people will do "the right thing", but simply leveraging the two aspects that drive human behaviour the most: economic incentive and necessity.

DC have a number of advantages over traditional systems of monetary exchange. They are distributed in nature, which means that transactions are verified by the majority of the nodes connected to the network, as is the creation of the currency itself. Their mathematical design makes it nearly impossible for a central authority or large institution to take over the system or manipulate the market. They don't require trust from any of the parties involved in the transaction, which is a huge advantage over credit cards, as the transaction is verified by the combined computational power of the network. They are ubiquitous, virtually infinitely scalable, and transaction costs are orders of magnitude lower than traditional currency, which makes them easy to be adopted globally. With DC, it is possible for any individual to exchange goods and services in the global market at virtually zero marginal cost. DC are safer than cash and credit cards, and they can't be controlled by local regimes or large nations with imperialistic tendencies. As the world becomes more globalised, it is clear that the tendency towards a global system of currencies is inevitable, as we've already seen various attempts in the past – all of which have failed, perhaps with the exception of the petrodollar, which is again tied to a centralised form of energy. DC have all the preconditions to take over the global system of exchange, and they are the perfect means through which the transition towards an open, collaborative, decentralised and distributed network of resilient nodes can occur.

Perhaps the most interesting aspect of DC is that they can be designed to be intrinsically deflationary (e.g. Bitcoin and Litecoin have an upper limit in the number of coins that can be created). This may sound like a terrible idea according to classical economics, but it could be the last step in the economic incentive towards a sustainable society. As discussed earlier, we can't expect people to behave in the proper way just because it's ultimately beneficial to them, as people are very bad at estimating long term consequences and are not always rational agents. But evidence shows that most people do act in their immediate self-interest. Following this reasoning, humanity will switch to a primary use of DC because of their immediate advantages (lower transaction costs, internationality, etc.), and currently the most widely used are deflationary in nature. This might bring to a global behavioural change, where only the truly necessary purchases and investments are made, because the expected return of investment will have to be higher than the inevitable increase in the value of the currency.

The emergence of Bitcoin is indeed very interesting. Might it be that the system "humans" is naturally evolving an enabler of a non-growth based cultural and economic system, one which will in the long run outcompete the growth-based paradigm, that has been beneficial up until some time ago, and without which the latter could not have existed? In other words, was growth inevitable to reach the conditions that would create an efficient and sustainable post-growth system?

Furthermore, will the new branch of the tree develop in parallel, avoiding the sudden collapse of the previous, or will it be created from a breaking point as a direct consequence of the first?

IV. Decentralised Decision Making

Bitcoin is not a currency. Broadly speaking, Bitcoin is a mathematically sound and secure way for different agents to agree on something. Currency just happens to be one of the implementations that organically emerged from the Bitcoin protocol. As societies become more complex, the systems of governance need to evolve in order to accommodate the new requirements. A voting system based on a Bitcoin-like protocol can ensure voting takes place in absence of frauds, all while not having to trust a central authority. It is infinitely scalable, and can dynamically adapt virtually to any situation. One example is distributed contract, a method of using Bitcoin to form agreements with people via the block chain. These contracts allow people to solve common problems in a way that minimizes trust, which makes things more convenient by allowing human judgements to be taken out of the loop, thus allowing complete automation.

Bitcoin-like cryptovoting systems can change the way we make decisions in the future, and can be adopted with minimal barrier to entry by anyone, from the smallest communities and organisations, to the largest supranational entities.

IV. Future scenarios

So far we've discussed the immediate future (a few decades at most). But it is also worth thinking about the future of humanity in much broader, cosmic terms. As mentioned earlier, the proposed socio-economic structure destabilises established powers through massively decentralised distributed resilient networks, and it questions the fundamental assumption of the constant need for indefinite exponential consumption. However, one could make the case that, given sufficiently advanced technologies, there is no such need. Some companies are already exploring the possibility of mining asteroids, which are plentiful, full of resources, and relatively close to us. In addition, the energy coming to Earth from the Sun is at least

5,000 times that which is required today, not to mention that fusion might become a viable and stable source of energy before the end of the century.

Plentiful energy and raw materials could be the new fuel that can enable our species to keep growing, without the need to change any of our economic and social tendencies. With enough energy and technology we can desalinate ocean water, grow food at will, and perhaps even restore the collapsing environment, so why bother searching for sustainability and resilience?

To understand why this is not a strategy for long term survival, we must look at past data and future projections, using simple mathematical calculations and basic analysis of thermodynamical processes.

The U.S. has been increasing its energy consumption consistently since we have significant data, circa 1650. Figure 1 shows global power demand under sustained 2.3% growth on a logarithmic plot. In 275, 345, and 400 years, we demand all the sunlight hitting land and then the earth as a whole, assuming 20%, 100%, and 100% conversion efficiencies, respectively. In 1350 years, we use as much power as the Sun generates. In 2450 years, we use as much as all hundred-billion stars in the Milky Way galaxy. A 2.3% growth rate used in this model is well below the annual growth rate of 2.9% the U.S. has experienced consistently since 1650.

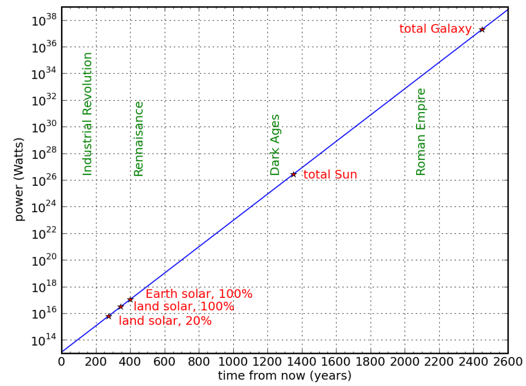

Figure 1: *Galactic Scale Energy (Murphy, 2012), logarithmic plot.*

Figure 2 shows expected Earth surface temperature given steady 2.3% energy growth, assuming some source other than sunlight is employed to provide our energy needs and that its use transpires on the surface of the planet. Even a dream source like fusion makes for unbearable conditions in a few hundred years if growth continues. Note that the vertical scale is logarithmic.

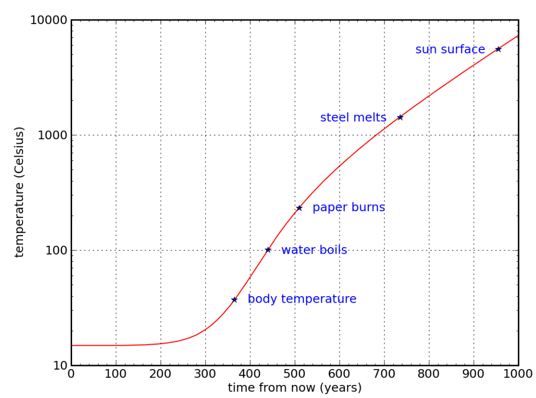

Figure 2: *Earth surface temperature over time (Murphy 2012), logarithmic plot.*

A positive note comes from Table 1. The U.S. energy consumption per capita, while still being excessively high, has plateaued at 87 mWh/year, while Europe is at a more reasonable 40 mWh/year.

kWh/capita			
Region	**1990**	**2008**	**Growth**
USA	89,021	87,216	-2%
EU-27	40,240	40,821	1%

Table 1: *Regional energy use (kWh/capita & TWh) and growth 1990–2008 (%). Source: IEA.*

Let's take the U.S. estimate and apply it to the number of people will inhabit the planet at the end of century, which according to the United Nations Population Fund is expected to stabilise at 10 billion. If we abandon the growth of per capita energy consumption and we stabilise at current energy level, this gives us a total yearly energy requirement for humanity at peak of 3.139776×10^{21} Joules, or 872,160 TWh, considering that all 10 billion people at the end of the century will have the same standards as North Americans do in 2014. According to recent estimates, the combined technical potential of renewables is 7.5×10^{18} Joules per year (7,500 EJ, $\sim$ 2 million TWh), while the theoretical limit is 1.43×10^{26} Joules (143 million EJ, $\sim$ 40 billion TWh). Table 2 summarises future scenarios.

2083 Global Energy Scenarios			
Levels	**Growth**	**Required**	**Available**
Europe	0%	0.4 EWh	2 EWh
USA	0%	0.8 EWh	2 EWh
USA	2.3%	4.3 EWh	2 EWh

Table 2: *Projected future energy requirements and availability in EWh (1 exawatt = 10^{18} watts = 1 million TW) assuming human population stabilises at 10 billion. Growth rate in the third row is relative to 2008 levels of U.S. consumption.*

If by 2083 we can stabilise population to 10 billion, adopt the European model of average energy consumption, and switch to 100% renewable energies, will will have a global energy requirement five times lower than what can be realistically captured using modern technologies, while having ample space on the theoretical side. Should we stabilise at U.S. level we'd have an available capacity a bit higher than twice the requirement. Should we instead continue on a growth trajectory, we would exceed the global capacity much sooner than 2083. Given the precautionary principle, the author suggests that through improvements in energy efficiency, a European lifestyle can easily be achieved with half the current rate of consumption, bringing it at 0.2 EWh in 2083, one order of magnitude less than the available renewable energies.

Let's not forget that energy, while being a good global indicator, is not at all sufficient when evaluating global sustainability. In 2011 the world used only 0.15 EWh (81.6% from fossil fuels and only 3.3% from truly renewables), but we used 147% of the available global resources. The total Earth's biocapacity in 2011 was estimated at 12 billion gha (global hectare, or 1.8 gha per person), but humanity's Ecological Footprint had reached 17.6 billion gha (or 2.6 gha per person). Correspondingly, the number of planets demanded by all humans had increased to 1.47 planets, which represented an increment of 2.4 times the demand for nature's renewable resources since 1961.

The only way for humanity to survive is to fully switch to distributed renewable energies, increase efficiency by a factor of 2, and reduce overall consumption of resources to lower than the Earth total biocapacity (which is likely to decrease to 10 gha or less in a few decades). Again, assuming a stabilised population of 10 billion by 2083, and an expected biocapacity of 10 gha or less, we should aim for a global average of less then 1 gha per capita. As a point of reference, the U.S. has been fluctuating around 7 gha per capita since the 1960s, Italy has grown from 2 gha to 4 gha, and Botswana has been stable at 2 gha. The great challenge will be to provide European or North American standards of living to 10 billion people at less than 1 gha, almost 1 order of magnitude less than the present way of using resources.

I. Existential Risks

Perhaps one of the greatest concerns when thinking about the long-term future of humanity is the risk of extinction. This can happen in a variety of ways, which include and are not limited to – molecular nanotechnology weapons and accidents, superintelligent AI, wars, engineered pandemic, nuclear war, natural pandemic, and nuclear or biological terrorism. Generally speaking, they can be clustered into the following categories:

1. Man-induced disasters due to power consolidation and resource exploitation.
2. Man-caused unintended accidents.
3. Natural events.

The risk of (1) can be greatly reduced by removing the need and the processes that allow for abuse of power and overconsumption to happen. In a resilient open source society of interconnected nodes, each as self-sufficient as possible, wars and imperialist behaviours tend to disappear naturally. Risk (2) can be mitigated by having a global network of highly secure and thoroughly tested nano machines, communicating with each other and acting like a swarm, ready to intervene in mass within a few microseconds should anything happen. If only open source tools are utilised, the structural integrity and security of the systems in place is maximised, as it is in the interest of the nodes of the network to preserve their own life and balance. This leaves us with risk category (3), which includes supervolcano eruptions, cyclical ice ages, megatsumani, geomagnetic reversal, meteorite impact, and extraterrestrial invasion. Aside from the last one, for which any strategy might be pointless if their technology is beyond our wildest imagination, the best strategy is to have an interconnected system of sensors deployed worldwide, ubiquitous satellites and telescopes scouting the skies from different angles, and to colonise neighbouring planets. This strategy serves as a double purpose, on one side we take care of the planet we currently inhabit and learn to live in balance with it, and we use the same techniques to make a backup of our species elsewhere (the most likely immediate candidate being Mars). Should the first condition fail to be satisfied (dynamic equilibrium with planet Earth first), the human race would essentially spread like a virus, uncontrolled in its use of natural resources. The inability to find a sustainable model first would result in the mere procrastination of the inevitable demise of the species, due to the mathematical impossibility of indefinite geometric growth.

V. Conclusions

The human species faced extinction before, but never by its own hands. In the author's view, assuming that people are rational agents and that they will act in the best long-term interest of humanity if they were educated enough and told how, is merely wishful thinking. Fighting inertial tendencies is not a good strategy and definitely not the most efficient use of resources. Instead, identifying the root causes of negative actions and steering just slightly the direction by promoting and developing processes and technologies that can change the conditions, can have huge positive consequences in the future with minimal use of resources. We have identified such conditions as the emergence of technologies that can enable massively decentralised distributed resilient networks and the abandonment of the indefinite consumption growth economic model.

Perhaps the multiverse hypothesis is true, and there are $10^{10^{10^7}}$ possible universes. Maybe the string theory landscape is correct, and there as many as 10^{500} false vacua. It could be that the number of parallel universes is infinite. Or we might be part of an elaborate computer simulation. We may never discover which hypothesis is true, but wouldn't it be great to live in one of the universes where we make it through this great challenge? Finally, it may very well be that our universe is the only one in existence, which would make our success even more special.

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